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lines of force, the resistance of a wire to an electric current. The shortest possible length for the magnetic circuit is obtained by giving a circular form to the machine. The result shows that the machines have come out very close to their estimated power, the

claimed to have considerable advantage over most slow-running fans. Two of these fans have been successfully employed to ventilate a hall 100 feet square, being placed opposite each other, and both used as exhausts. Another method employed is to place one

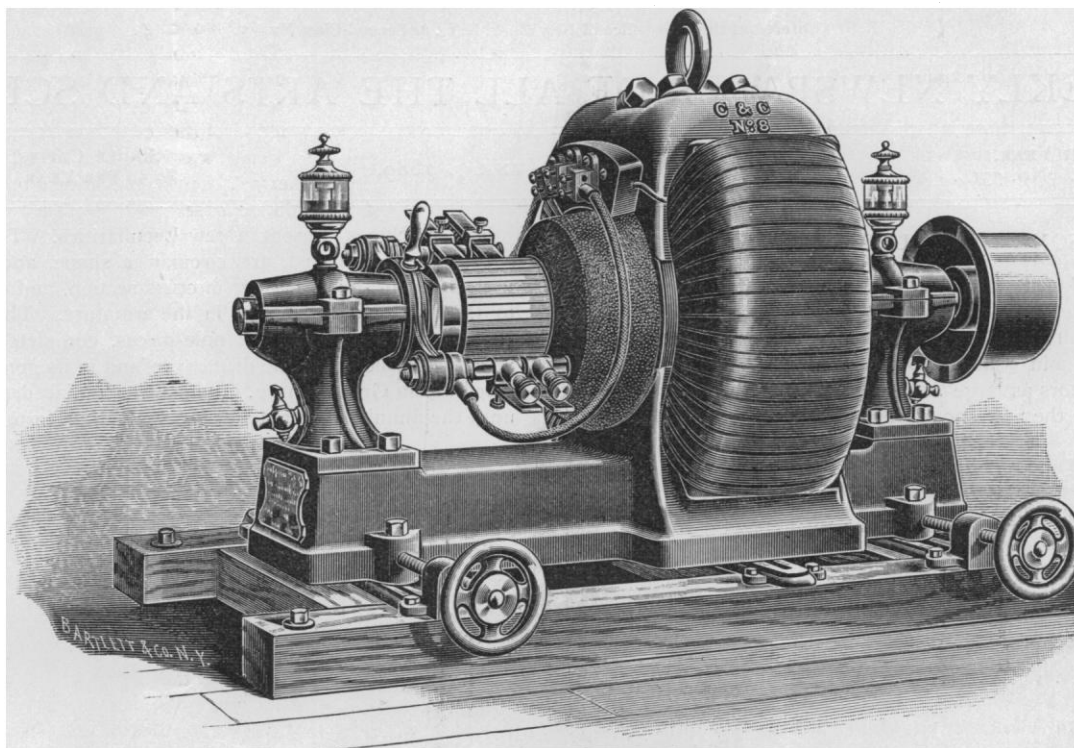


FIG. 2.—THREE-HORSE-POWER C. & C. MOTOR.

actual number of volts developed being 109 against 110 in a 3-horse power motor. It has been aimed at to eliminate Foucault's currents and undue heating.

of these fans at either end of a hall, one running as an exhaust, and the other forcing air in.

WATER-FILTRATION.

PROBABLY at no time has the condition of the water-supply of our cities and towns received more attention than at present, and perhaps no one thing has conduced to this state of affairs more than the discovery that certain salts contained in the earth act as renovators of all so-called "spring" waters, purging them, so to speak, of the foul matters held both in solution and in suspension.

Up to the time of this discovery, it was thought that the earth acted merely as a filter or strainer on a large scale, and that each grain or atom of earth acted its part toward opposing or arresting impurities in the passing water; in other words, that only mechanical straining or filtering took place, and nothing more.

Multitudes of filters have been made and put in operation in all ages and countries with the expectation of seeing the water emerge from them as pure and sparkling as from a good "spring," and the greatest surprise has been manifested at the failure to secure the same results when apparently every condition was supplied. The question remains, "Was every condition supplied?" Modern science answers, "No."

The peculiar action of the above salts upon the portion of impurities said to be held in solution is well illustrated by the effects produced by dissolving soap in a water of great (so called) hardness. The white flakes that almost instantly appear are composed not alone of dissolved soap (for soft water would not show such individualized flakes), but a mixture of soap and some substance hitherto held in undisturbed solution in the water, but now withdrawn from that condition and floating about in mechanical suspension.

It will be plain that if this soap-treated water was now poured into the earth at one point, and made to emerge at another some distance off, it would be found purged of not alone the soap it contained, but also of the modicum of foreign matter held in its embrace, and which went to make up the quality of hardness spoken of.

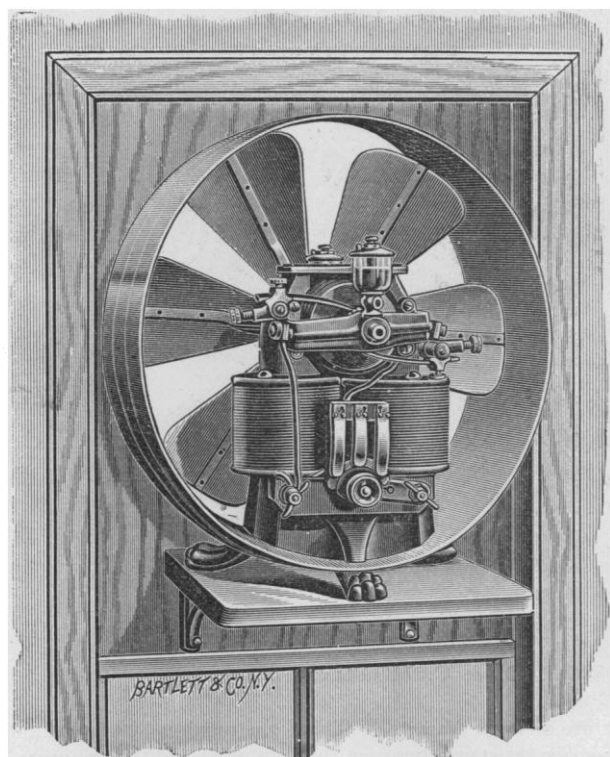


FIG. 3.—THE C. & C. COMPANY'S MOTOR AND EXHAUST FAN.

Another application of this motor is to the driving of ventilating-fans. Fig. 3 shows a $\frac{1}{4}$ -horse-power incandescent motor fan outfit. This apparatus at a speed of one thousand revolutions a minute is

This subject is so little (generally) understood, that it seems necessary to use the above illustration for the benefit of the casual reader, although to the chemist a hundred different applications of the same law will suggest themselves. Indeed, it is noted here for the purpose of calling more emphatic attention to the simple fact that water may contain impurities in absolute (chemical) solution, and that such impurities, by the addition of another substance, may be rendered tangible, and capable of withdrawal from the water by purely mechanical means.

Equally clear and understood should be the statement that water may contain impurities in a state of fine (mechanical) suspension,—so fine that they would flow wherever water would flow,—and these, by the addition of another substance to the water, be made to flock together into groups, a thousand or two into one (as clouds are condensed into drops); and that one, with its fellows, be tangible, and easily removed from the water by purely mechanical means.

It follows, that if the earth contains in abundance this “substance,” which has the dual property of disengaging matter held in solution, and rendering the same tangible, and also of curdling together matter held in so fine a state of division as to almost elude the senses into a state of perfect tangibility, we at once get at the secret of how nature makes the true spring-water, so wonderfully pure and sweet to the taste, as well as brilliantly clear, and inviting to the eye.

What is this substance or substances? Usually some combination of lime, iron, potassium, aluminum, etc., with other bases, such as sulphur or carbon,—all existing naturally in the great mother matrix, the earth.

The almost universal diffusion of the aluminiferous earth (red clay) makes that substance take a more prominent place among the agents above alluded to. Water cannot flow far in any part of the world without encountering in its course the coagulating or curdling effect of this single element. Some of these clays are more heavily charged or freighted with aluminous compounds than others. Waters fouled by such are more quickly subsided. In this fact we have a clew to the explanation of why it is, that, of two different waters showing the same degree of turbidity from clayey impurities, such impurities will subside quickly in one, while in the other they may not subside in months. As proof that the quick subsidence is due to the presence of these salts, we have only to add a minute proportion of such (usually aluminum sulphate) to the other water to produce the same effect. Hence, when water issues from the earth in a very clear and perfect state, we may always be sure that it has encountered somewhere on its travels a body of earth or mineral containing a suitable coagulant, the action of which coagulant upon the water accounts for its wonderful purity aside from and entirely independent of the mere filtering effect of the earth.

It has remained for the present decade to apply the above knowledge to the art of filtration of water, and for the first time produce results equal to nature.

As this industry extends, it will become a common thing to see “spring” water issue from our city faucets, as is already the case in a few American cities, notably Atlanta, Long Branch, and Newport.

The study of this subject furnishes a striking example of Nature’s exhibiting, in the humble wayside “spring,” the results of her perfect handiwork for the observation and admiration of man throughout all ages and countries, only to deliver up her secret to the pale student of this century of science.

JOHN A. CALDWELL.

THE USE OF SPIRIT AS AN AGENT IN PRIME MOVERS.

A PAPER on the above subject was prepared by A. F. Yarrow at the request of the Council of the London Society of Arts, and was presented May 22. It did not treat of the adoption of spirit or liquid hydrocarbons, such as petroleum, when used as a substitute for coal as fuel, which is an entirely distinct subject, but with the use of volatile liquids in lieu of water, to produce power, when converted by heat from the liquid to the vapor state, in the

same way that power is obtained from the conversion of water into steam.

In the year 1856 this subject attracted much attention in France; and, as a matter of fact, several large steamers were built, and ran between Marseilles and Algiers, in which ether was evaporated in combination with steam for working the propelling machinery. The engines were on the Du Tremblay system. The steam, after having performed work in one cylinder, instead of going at once to the condenser, was used to evaporate ether in a tubular evaporator, by which means a portion of the remaining heat in the steam was absorbed instead of being wasted. The ether vapor so produced was used in another cylinder, the additional power thus obtained being a clear gain. These steamers ran, making regular voyages, for some years, but were ultimately abandoned.

The gain obtained is clearly due to the ether taking a portion of the heat of the exhaust steam, and turning it to useful account, which would otherwise be wasted in raising the temperature of the condensing-water. The ether used evaporates at about 104° F.: it will therefore be seen to what a low temperature the steam or water can be brought down, and still be useful in evaporating the ether.

The system was no doubt economical as regards fuel; but the ether was so difficult to keep, that a renewal of about one gallon per hour was required to make good the leakages. There was also serious risk of explosion on account of these leakages, because the ether, when free, rapidly vaporizes, and when in this state is explosive if mixed with the atmosphere. The difficulties which at that time had to be dealt with are, however, now greatly reduced. Ether, being the spirit used, was far more costly than other volatile liquids which are available now, and consequently any leakage then represented an important item in the working expenses; also, at that period, means for obtaining good workmanship were not available to the engineer, as they are at present, accuracy of workmanship, and soundness of materials, being essential points in dealing with the vapor of these volatile liquids, as it penetrates joints and castings which no steam would. In fact, an amount of care is necessary beyond what is needed in the best steam-engine practice, and sufficiently good work was not available thirty-two years ago.

The success of some small boats lately built in the United States, propelled by spirit vapor, induced Mr. Yarrow to take the matter up with a view to investigate it, and see whether the results would justify his going fully into the matter with a view to its further development. These preliminary investigations look promising.

The apparatus with which the experiments were tried was a small steam-engine of ordinary construction, which actuates a shaft and fly-wheel in the usual way. There was a brake attached to the shaft, with a spring balance and index; also a revolution counter, so that he was enabled to obtain the actual power developed. There was also fitted to this little engine an ordinary indicator, from which to obtain diagrams.

The steam-boiler had no special feature about it: it had simply a combustion-chamber and a straight flue through to the funnel. There was no attempt at economy of fuel, because there was no object in so designing it, all he wished to obtain being the comparative results on a common basis. The heat was obtained by means of ordinary gas, burnt in a large Bunsen burner. Gas was selected as the means of heating because the exact quantity could be accurately regulated and recorded, and with this view there was attached to the inlet pipe a gas-meter. The exhaust from the cylinder passed out, and terminated in a coil of pipe immersed in a tank of running water for the purpose of condensing the steam. From there the condensed steam ran into a hot-well, and passed on to the feed-pump on the engine, and was forced back into the boiler, so that an entire circuit was made. This completes the arrangement for working the engine by steam.

For the corresponding system, when spirit vapor was used, inside the upper part of the boiler was a copper coil, the inlet to which was at the side, and the outlet at the top, whence it passed to the engine. The exhaust pipe from the cylinder was led in this case into a tank where the vapor was condensed, and passed on to the hot-well, thence to the pump, and was forced back into the coil inside the boiler, thus making this circuit complete. Two sets of pipes, condensing-coils, etc., were adopted, so as to avoid, as far as